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TITLE: MANUAL GAIN SETTING SYSTEM FOR GAIN CONTROL CIRCUIT AND
ITS METHOD

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ABSTRACT:

PROBLEM TO BE SOLVED: To set a plurality of advance setting values with a simple operation in the case of setting of a manual gain control(MGC) in a gain control circuit where an AGC system (automatic gain control system) or an MGC system (manual gain setting system) is selected.

SOLUTION: This gain control (AGC) circuit 1 has a function that selects an AGC state or an MGC state for a high frequency amplifier 2 that amplifies a high frequency signal with a variable gain. An AGC loop is provided with a variable gain amplifier 2, a detector 5, a comparator 6, a gain control voltage generating circuit 7, a time constant circuit 8 and an automatic/manual

changeover switch 9. When the switch 9 is thrown to the position of the MGC, the AGC loop is open and a control voltage Vc generated by a manual gain setting circuit 10 acts like a manual gain control signal, which is fed to a gain control terminal 11 of the amplifier 2. The manual gain setting circuit 10 applies the manual gain control signal produced through selection of any of a plurality of changeover terminals to the amplifier 2 to set any of a plurality of predetermined gains to the amplifier 2.

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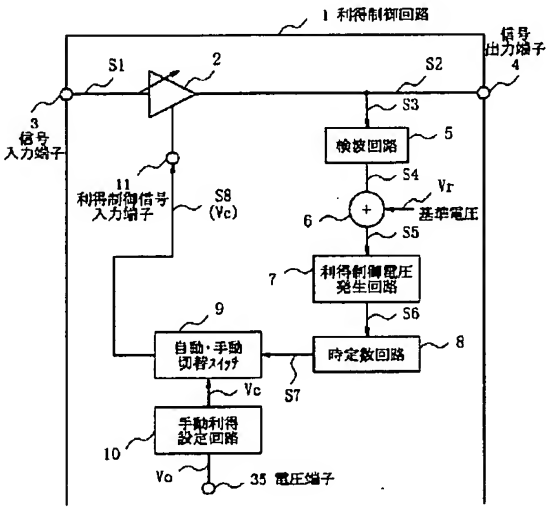
(54)【発明の名称】　利得制御回路の手動利得設定方式およびその方法

(57)【要約】
【課題】ＡＧＣ方式とＭＧＣ方式とが切替可能な利得制御回路において、手動利得（ＭＧＣ）設定時に、複数の事前設定値を簡単な操作で設定できる。
【解決手段】この利得制御（ＡＧＣ）回路１は高周波数信号を可変利得増幅する高周波増幅器２をＡＧＣ状態とＭＧＣ状態とに切り替える機能を有する。ＡＧＣループは、可変利得の増幅器２と、検波器５と、比較器６と、利得制御電圧発生回路７と、時定数回路８と、自動・手動切替スイッチ９とを備える。スイッチ９をＭＧＣに切り替えると、ＡＧＣループは開放され、手動利得設定回路１０が発生する制御電圧Ｖｃが手動利得制御信号となって増幅器２の利得制御端子１１に供給される。手動利得設定回路１０は、複数の切替端子の一つを選択することによって生じる手動利得制御信号の供給によって予め定められた複数の利得値の一つを増幅器２に設定することができる。



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【特許請求の範囲】

【請求項１】　高周波数信号を可変利得増幅する高周波増幅器を自動利得制御状態と手動利得設定状態とに切り替える機能を有する利得制御回路であって、

前記手動利得設定状態では，複数の切替端子の一つを選択することによって生じる手動利得制御信号の供給によって予め定められた複数の利得値の一つを前記高周波増幅器に設定する利得設定手段を備えることを特徴とする利得制御回路の手動利得設定方式。

【請求項２】　前記利得設定手段が、所定の電圧を生じる電圧源と複数の前記切替端子との間に互いに異なる抵抗値の複数の抵抗器をそれぞれ接続した切替手段と、前記切替手段の共通端子に生じる電圧を前記手動利得制御信号として前記高周波増幅器の利得制御端子に供給する手動利得制御信号供給手段とを備えることを特徴とする請求項１記載の利得制御回路の手動利得設定方式。

【請求項３】　前記高周波増幅器が、前記高周波数信号の通路に並列又は直列に配置されると共に前記手動利得制御信号を供給されて前記高周波数信号の可変減衰動作を行うＰＩＮダイオードを含むことを特徴とする請求項２記載の利得制御回路の手動利得設定方式。

【請求項４】　前記利得設定手段が、所定のアドレスデータの入力により対応するデジタル信号を生じるデータ入力回路と、前記デジタル信号を対応するアナログ電圧に変換するＤ／Ａコンバータと、前記アナログ電圧を前記手動利得制御信号として前記高周波増幅器の利得制御端子に供給する電圧供給手段とを備えることを特徴とする請求項１記載の利得制御回路の手動利得設定方式。

【請求項５】　高周波数信号を可変利得増幅する高周波増幅器を自動利得制御状態と手動利得設定状態とに切り替える機能を有する利得制御回路の手動利得設定方法であって、

前記手動利得設定状態では，複数の切替端子の一つを選択することによって生じる手動利得制御信号の供給によって予め設定された複数の利得値の一つを前記高周波増幅器に設定することを特徴とする利得制御回路の手動利得設定方法。

【請求項６】　所定の電圧を生じる電圧源と切替回路の前記複数の切替端子との間に互いに異なる抵抗値の複数の抵抗器をそれぞれ接続して前記複数の切替端子にそれぞれ前記手動利得制御信号を生じさせ、前記切替端子の一つの選択によって前記手動利得制御信号の一つを前記切替回路の共通端子から前記高周波増幅器の利得制御端子に供給することを特徴とする請求項５記載の利得制御回路の手動利得設定方法。

【請求項７】　前記高周波増幅器の前記高周波数信号の通路に並列又は直列に配置したＰＩＮダイオードに前記手動利得制御信号を供給して前記高周波数信号を可変減衰させることを特徴とする請求項６記載の利得制御回路の手動利得設定方法。

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【請求項８】　データ入力回路への所定のアドレスデータの入力により対応するデジタル信号を生じさせ、前記デジタル信号をＤ／Ａコンバータにより対応するアナログ電圧の前記手動利得制御信号に変換し、前記手動利得制御信号を前記高周波増幅器の利得制御端子に供給することを特徴とする請求項５記載の利得制御回路の手動利得設定方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は高周波数信号の利得制御回路（ＡＧＣ回路）の手動利得設定方式およびその方法に関し、特に自動利得制御方式（ＡＧＣ方式）と手動利得設定方式（ＭＧＣ方式）とが切替可能な利得制御回路の手動利得設定方式及びその方法に関する。

【０００２】

【従来の技術】従来のこの種の利得制御回路として特許第２７７８２６０号が開示されている。開示された利得制御回路は、手動利得調整時には、自動利得制御時に上記利得制御回路の利得を自動制御する自動利得制御信号に代えて、手動で可変できる電圧（手動利得制御信号）を供給して利得を変化・設定させている。なお、開示された特許公報には、手動で可変電圧を生じる手段については記載されていないが、一例として、図６の手動可変電圧発生回路の回路図に示す手段が考えられる。

【０００３】図６を参照すると、可変抵抗器ＲＶ６１は、端子６０から一端に定電圧Ｖ０を印可し，他端を接地し，中央端子から端子６２に可変の電圧Ｖｃａを生じる。可変抵抗器６１の回転子を回すと、一端と他端と間で一定抵抗値の抵抗体を持つ可変抵抗器ＲＶ６１の中央端子の上記抵抗体上の位置が変化し、接地電位に対する中央端子の電圧Ｖｃａが自由に設定できる。従って、図６に示した（可変抵抗器）回路から生じる可変電圧Ｖｃａを上記手動利得制御信号として用いることにより、上記利得制御回路の手動利得設定時には、利得を連続的に変化させることができる。

【０００４】

【発明が解決しようとする課題】上述の利得制御回路では、手動による利得の設定を連続的に変化させることができる反面、ＡＧＣ回路の設定利得が分からない（特定できない）ため、高周波数信号の入出力特性等の利得に関する事項を測定器でモニターして上記設定利得を測定する必要があった。即ち、ＡＧＣ回路は、運用時には手動による利得設定は本来不要であるが、装置のメンテナンス時や製造時には利得を手動設定して検査を行ないたい場合がある。特に、同一種類のＡＧＣ回路を多数製造する場合などには、毎回の利得測定について正確，且つ複数の利得設定を簡単な操作で繰り返し再現できることが製造コストの削減のために必要である。

【０００５】従って本発明の目的は、上述した従来技術の欠点を解消し、ＡＧＣ回路の手動利得設定時に複数の

事前設定値を簡単な操作で設定できる，ＡＧＣ方式とＭＧＣ方式とが切替可能な利得制御回路の手動利得設定方式及びその方法を提供することにある。

【０００６】

【課題を解決するための手段】本発明の一つによる利得制御回路の手動利得設定方式は、高周波数信号を可変利得増幅する高周波増幅器を自動利得制御状態と手動利得設定状態とに切り替える機能を有する利得制御回路であって、前記手動利得設定状態では，複数の切替端子の一つを選択することによって生じる手動利得制御信号の供給によって予め定められた複数の利得値の一つを前記高周波増幅器に設定する利得設定手段を備える。

【０００７】前記手動利得設定方式の一つは、前記利得設定手段が、所定の電圧を生じる電圧源と複数の前記切替端子との間に互いに異なる抵抗値の複数の抵抗器をそれぞれ接続した切替手段と、前記切替手段の共通端子に生じる電圧を前記手動利得制御信号として前記高周波増幅器の利得制御端子に供給する手動利得制御信号供給手段とを備える構成をとることができる。

【０００８】該利得制御回路の手動利得設定方式は、前記高周波増幅器が、前記高周波数信号の通路に並列又は直列に配置されると共に前記手動利得制御信号を供給されて前記高周波数信号の可変減衰動作を行うＰＩＮダイオードを含む構成をとることができる。

【０００９】前記利得制御回路の手動利得設定方式の別の一つは、前記利得設定手段が、所定のアドレスデータの入力により対応するデジタル信号を生じるデータ入力回路と、前記デジタル信号を対応するアナログ電圧に変換するＤ／Ａコンバータと、前記アナログ電圧を前記手動利得制御信号として前記高周波増幅器の利得制御端子に供給する電圧供給手段とを備える構成をとることができる。

【００１０】本発明の一つによる利得制御回路の手動利得設定方法は、高周波数信号を可変利得増幅する高周波増幅器を自動利得制御状態と手動利得設定状態とに切り替える機能を有する利得制御回路の手動利得設定方法であって、前記手動利得設定状態では，複数の切替端子の一つを選択することによって生じる手動利得制御信号の供給によって予め設定された複数の利得値の一つを前記高周波増幅器に設定する。

【００１１】前記利得制御回路の手動利得設定方法の一つは、所定の電圧を生じる電圧源と切替回路の前記複数の切替端子との間に互いに異なる抵抗値の複数の抵抗器をそれぞれ接続して前記複数の切替端子にそれぞれ前記手動利得制御信号を生じさせ、前記切替端子の一つの選択によって前記手動利得制御信号の一つを前記切替回路の共通端子から前記高周波増幅器の利得制御端子に供給する方法をとることができる。

【００１２】該利得制御回路の手動利得設定方法は、前記高周波増幅器の前記高周波数信号の通路に並列又は直

列に配置したＰＩＮダイオードに前記手動利得制御信号を供給して前記高周波数信号を可変減衰させる方法をとることができる。

【００１３】前記利得制御回路の手動利得設定方法の別の一つは、データ入力回路への所定のアドレスデータの入力により対応するデジタル信号を生じさせ、前記デジタル信号をＤ／Ａコンバータにより対応するアナログ電圧の前記手動利得制御信号に変換し、前記手動利得制御信号を前記高周波増幅器の利得制御端子に供給する方法をとることができる。

【００１４】

【発明の実施の形態】次に、本発明について図面を参照して説明する。

【００１５】図１は本発明の実施の形態の一つによるＡＧＣ回路のブロック図である。

【００１６】このＡＧＣ（自動利得制御）回路１は信号入力端子３から高周波数信号Ｓ１をトランジスタ等を含む利得可変の増幅器２に受ける。増幅器２は高周波数信号Ｓ１を増幅して信号出力端子４に高周波数信号Ｓ２を出力する。また、増幅器２が出力する高周波数信号の一部が高周波数信号Ｓ２と分岐され、この分岐された高周波数信号Ｓ３はダイオード検波器等を含む検波回路５に供給される。検波回路５は、高周波数信号Ｓ３を検波し、信号出力端子４に生じる高周波数信号Ｓ２の信号レベルを直流ないし低周波数信号の検波電圧Ｓ４として出力する。

【００１７】検波電圧Ｓ４は、比較器６によって、このＡＧＣ回路１から出力される高周波数信号Ｓ２の信号レベルを規定する基準電圧Ｖｒと比較される。検波電圧Ｓ４と基準電圧Ｖｒとが等しいとき、ＡＧＣ回路１の出力（Ｓ２）は規定信号レベルとなる。一方、検波電圧Ｓ４と基準電圧Ｖｒとに差がある場合には、比較器６から誤差電圧Ｓ５が演算増幅器等である利得制御電圧発生回路７に供給され、利得制御電圧発生回路７は誤差電圧Ｓ５を適切なレベルまで増幅し，その自動利得制御信号Ｓ６を時定数回路８に供給する。低域通過ろ波器でもある時定数回路８は、誤差電圧Ｓ５の信号帯域を適切な帯域に制限し、増幅器２，検波回路５，比較器６，利得制御電圧発生回路７及び自動・手動切替スイッチ９からなるＡＧＣループの帯域をほぼ決定する。時定数回路８からの自動利得制御信号Ｓ７は、ＡＧＣ回路１をＡＧＣ方式またはＭＧＣ方式に切り替える自動・手動切替スイッチ９に供給される。

【００１８】ＡＧＣ回路１をＡＧＣ方式で動作させる場合（自動利得制御状態）には、自動利得制御信号Ｓ７とほぼ同じ電圧の自動利得制御信号Ｓ８を自動・手動切替スイッチ９から増幅器２の利得制御信号入力端（利得制御端子）１１に供給する。なお、自動・手動切替スイッチ９は、共通端子を増幅器２の利得制御信号入力端１１に接続する単極双投スイッチを使用することができる。

増幅器２には利得を減少させる可変減衰器が内蔵されており、利得制御信号Ｓ８は上記可変減衰器の減衰量を制御して高周波数信号Ｓ２のレベルが上記規定レベルになるように増幅器２の利得制御をする。

【００１９】一方、ＡＧＣ回路１をＭＧＣ方式で動作させる場合（手動利得制御状態）には、上記ＡＧＣループが自動・手動切替スイッチ９によってループを開放される。そして、自動・手動切替スイッチ９は、手動利得設定回路１０から制御電圧Ｖｃをうけ、この制御電圧Ｖｃを手動利得設定信号として増幅器２の利得制御信号入力端１１に供給する。この結果、増幅器２の利得は制御電圧Ｖｃに対応する利得に設定される。

【００２０】ここで、所定の電圧Ｖ０を電圧端子３５に受け，電圧Ｖ０を制御電圧Ｖｃの電源とする手動利得設定回路１０は、複数の切替端子を有する切替手段，例えばロータリースイッチの切替端子の一つを選択することによって、予め設定された複数の互いに異なる電圧の制御電圧Ｖｃの一つを出力端子に生じさせることができる。従って、ＭＧＣ方式として動作するＡＧＣ回路１は、手動利得設定回路１０が発生する予め設定された複数の互いに異なる電圧の制御電圧（手動利得設定信号）Ｖｃ（の一つ）を受けて，複数の互いに異なる利得（の一つ）を設定することができる。

【００２１】また、このＭＧＣ方式として動作するＡＧＣ回路１は、自動・手動切替スイッチ９及び手動利得設定回路１０を利得測定器と連動させることにより、複数の利得測定点をコンピュータ制御により自動的に利得測定させることはごく簡単であり、このことにより、省力化は一層の効果を上げることができる。

【００２２】上述の通り、図１の実施の形態によるＡＧＣ回路１は、ＡＧＣ方式とＭＧＣ方式とが切替可能なＡＧＣ回路の手動利得設定時に、複数の事前設定値を簡単な操作でそれぞれ設定できるという効果がある。これは装置のメンテナンス時や製造時に利得を手動設定して検査を行なう場合，特に、同一種類のＡＧＣ回路を多数製造する場合などには、毎回の利得測定について正確且つ複数の設定値を簡単な操作で繰り返し再現でき、大きな製造コストの削減ができるという特徴がある。

【００２３】図２は図１に示した増幅器２の動作を説明する図であり、（ａ）は詳細回路図、（ｂ）は制御電圧Ｖｃと増幅器２の利得Ａとの関係を示す図である。

【００２４】図２を参照すると、増幅器２は、高周波数信号Ｓ１を電界効果トランジスタ（ＦＥＴ）等で増幅する増幅器２１と、増幅器２１の後段に縦続接続され，可変減衰器として動作するＰＩＮダイオード２２とを主な構成要素とする可変利得増幅器である。ＰＩＮダイオード２２はアノードが高周波数信号の線路に接続され，カソードが接地されている。上記アノードと利得制御信号入力端子１１とが接続され、自動利得制御状態（ＡＧＣ方式）には自動利得制御信号Ｓ８が，手動利得制御状態

（ＭＧＣ方式）には制御電圧（手動利得制御信号）Ｖｃがそれぞれ供給される。なお、上記アノードと利得制御信号入力端子１１との間には、チョークコイルや抵抗器等の高周波数信号のリーク防止回路（図示せず）が設けられる。また、ＰＩＮダイオード２２には直流電流が流れるが、この直流電流が増幅器２１や外部回路に流れて互いに悪影響を及ぼさないように、増幅器２１とＰＩＮダイオード２２との間にコンデンサＣ２１を，ＰＩＮダイオード２２と増幅器２１の出力端との間にコンデンサＣ２２をそれぞれ直流阻止のために挿入している。

【００２５】いま、利得制御信号入力端子１１に正電圧の制御電圧Ｖｃが印可される（ＭＧＣ方式の場合）と、ＰＩＮダイオード２２の高周波数信号に対する抵抗値が５０Ω（高周波数信号の周波数によって異なる）以上の値から制御電圧Ｖｃが大きくなるに従って数Ω程度まで減少する。従って、制御電圧Ｖｃの増加に伴ってＰＩＮダイオード２２による高周波数信号の減衰量が増加するので、増幅器２全体の利得Ａが低下し、増幅器２は可変利得増幅器として動作する（（ｂ）参照）。図２（ｂ）から、増幅器２に所望の利得Ａを得るための制御電圧Ｖｃの値が分かる。

【００２６】図３は図１の実施の形態に示した増幅器２に代えて用いることのできる増幅器２Ａの動作を説明する図であり、（ａ）は詳細回路図、（ｂ）は制御電圧Ｖｃと増幅器２Ａの利得Ａとの関係を示す図である。

【００２７】図３を参照すると、増幅器２Ａも、増幅器２１と、増幅器２１の後段に縦続接続されたＰＩＮダイオード２２とを主な構成要素とする可変利得増幅器である。但し、ＰＩＮダイオード２２はアノードが高周波数信号の線路に直列に接続されている。上記アノードと利得制御信号入力端子１１とが接続され、自動利得制御状態には利得制御信号Ｓ８が，手動利得制御状態には制御電圧Ｖｃがそれぞれ供給される。なお、上記アノードと利得制御信号入力端子１１との間には、チョークコイルや抵抗器等の高周波数信号のリーク防止回路（図示せず）が設けられる。また、ＰＩＮダイオード２２のカソードは、制御電圧Ｖｃのリターン回路を作るために抵抗器Ｒ２１で接地されている。さらに、図２の場合と同様に、増幅器２１とＰＩＮダイオード２２との間にコンデンサＣ２１を，ＰＩＮダイオード２２と増幅器２１の出力端との間にコンデンサＣ２２をそれぞれ直流阻止のために挿入している。

【００２８】いま、利得制御信号入力端子１１に正電圧の制御電圧Ｖｃが印可される（ＭＧＣ方式の場合）と、ＰＩＮダイオード２２の高周波数信号に対する抵抗値が制御電圧Ｖｃが大きくなるに従って減少する。従って、制御電圧Ｖｃの増加に伴ってＰＩＮダイオード２２による高周波数信号の減衰量が減少し、増幅器２Ａ全体の利得Ａが増加し、増幅器２Ａも可変利得増幅器として動作する（（ｂ）参照）。増幅器２Ａに所望の利得Ａを得る

ための制御電圧Ｖｃの値は、図２（ｂ）から決定することができる。なお、増幅器２と２Ａとは、制御電圧Ｖｃに対する利得変化が逆であり、ＡＧＣ回路１にどちらを採用するかは、高周波数信号Ｓ２のレベル変化に対する利得制御電圧発生回路６からの利得制御電圧Ｓ５のレベル変化方向，或いは制御電圧Ｖｃの設定の仕方によって定まる。

【００２９】なお、図２及び図３に示した増幅器２及び２Ａにおいて、状況によってＰＩＮダイオード２２は増幅器２１の前段に配置して良いことは勿論である。

【００３０】図４は図１のＡＧＣ回路１に使用した手動利得設定回路１０の一例の構成図である。

【００３１】この手動利得設定回路１０は、複数の切替端子を有する接続切替回路として用いるロータリースイッチ３０と互いに抵抗値の異なる複数の抵抗器３６，３７及び３８を備えている。ロータリースイッチ３０の共通端子３１は自動・手動切替スイッチ９の切替端子の一つに接続されている。また、ロータリースイッチ３０の切替端子３２，３３及び３４には、抵抗器３６，３７及び３８がそれぞれ接続されている。そして、抵抗器３６，３７及び３８の別の端子は所定の電圧Ｖ０を供給される電圧端子３５に共通接続されている。電圧Ｖ０及び抵抗器３６，３７及び３８の抵抗値は、図２及び図３において、増幅器２又は２Ａに所望の利得Ａをそれぞれ生じさせる制御電圧Ｖｃが得られる値，つまりＰＩＮダイオード２２に所望の制御電圧Ｖｃを印可できる値に決めることになる。なお、ロータリースイッチ３０の切替端子の数，及びこの切替端子に対応する抵抗器の数は、増幅器２又は２Ａの所望の利得設定値の数に合わせて決定してよいことは勿論である。

【００３２】いま、ロータリースイッチ３０の共通端子３１の軸を回すと、共通端子３１に接続される切替端子が変わる。その結果、共通端子３１に接続される抵抗器が変化する。このロータリースイッチ３０の接続切替により、上記抵抗器は抵抗器３６，３７及び３８のどれかに切替選択されことになる。ＭＧＣ方式では電圧端子３５に本図の抵抗器と図２又は図３のＰＩＮダイオード２２とが接地電位との間に直列に接続されるので、ロータリースイッチ３０による上記抵抗器の切替選択は、ＰＩＮダイオード２２に印可される制御電圧Ｖｃを変化させることになる。従って、変化できる制御電圧Ｖｃの値を所望の利得Ａを得る電圧にしておくことで、ロータリースイッチ３０の切替端子の指示目盛りと増幅器２又は２Ａの利得Ａとを一対一に対応させることができる。

【００３３】上述の通り、図４に示した複数の切替端子を有する切替回路と上記複数の切替端子にそれぞれ接続された互いに抵抗値の異なる抵抗器との組み合わせ回路は、上記切替回路の共通端子が接続される切替端子に応じてＭＧＣ方式の制御電圧Ｖｃをそれぞれ設定しておくことで、正確，且つ複数の設定値を簡単な操作で繰り返し再現できるという特徴がある。これは、同一種類のＡＧＣ回路１を多数製造する場合など、増幅器２または２Ａの毎回の利得測定をＭＧＣ方式によって行う場合に省力化のために特に有効である。

【００３４】図５は図１のＡＧＣ回路１に使用できる別の手動利得設定回路１０Ａの構成図である。

【００３５】この手動利得設定回路１０Ａにおいて、複数のデータ１～ｎ（ｎは正の整数）を記憶するデータ入力回路４３は、所定のアドレスデータＳ４１の入力により対応するデジタル信号Ｓ４２を出力する。このデジタル信号Ｓ４２の値は、増幅器２又は２Ａの利得制御信号入力端１１に供給すべき制御電圧Ｖｃにそれぞれ対応している。例えばアドレスデータＳ４１がデータｎの場合は制御電圧Ｖｃｎに対応している（（ｂ）参照）。デジタル信号Ｓ４２はＤ／Ａコンバータ４０に供給され、Ｄ／Ａコンバータ４０はデジタル信号Ｓ４２を対応するアナログ電圧Ｓ４３に変換する。このアナログ電圧Ｓ３は、手動利得設定回路１０Ａの出力端子４１から自動・手動切替スイッチを介して増幅器２又は２Ａの利得制御信号入力端１１に供給され、制御電圧Ｖｃとして増幅器２又は２Ａ内蔵の可変減衰器の減衰量を制御する。この手動利得設定回路１０Ａはコンピュータ制御されるＡＧＣ回路１のＭＧＣ方式での使用に特に適している。

【００３６】

【発明の効果】以上説明したように本発明は、高周波数信号を可変利得増幅する高周波増幅器を自動利得制御状態と手動利得設定状態とに切り替える機能を有する利得制御回路であって、前記手動利得設定状態では，複数の切替端子の一つを選択することによって生じる手動利得制御信号の供給によって予め定められた複数の利得値の一つを前記高周波増幅器に設定する利得設定手段を備えるので、上記ＡＧＣ回路の手動利得設定時に、複数の事前設定値を簡単な操作で設定できるという効果がある。これは装置のメンテナンス時や製造時には利得を手動設定して検査を行なう場合，特に、同一種類のＡＧＣ回路を多数製造する場合などには、毎回の利得測定について正確，且つ複数の設定値を簡単な操作で繰り返し再現でき、大きな製造コストの削減ができるという効果を生じる。

【図面の簡単な説明】

【図１】本発明の実施の形態の一つによるＡＧＣ回路のブロック図である。

【図２】図１に示した増幅器２の動作を説明する図であり、（ａ）は詳細回路図、（ｂ）は制御電圧Ｖｃと増幅器２の利得Ａとの関係を示す図である。

【図３】図１の実施の形態に示した増幅器２に代えて用いることのできる増幅器２Ａの動作を説明する図であり、（ａ）は詳細回路図、（ｂ）は制御電圧Ｖｃと増幅器２Ａの利得Ａとの関係を示す図である。

【図４】図１のＡＧＣ回路１に使用した手動利得設定回

路１０の一例の構成図である。

【図５】図１のＡＧＣ回路１に使用できる別の手動利得設定回路１０Ａの別の一例の構成図である。

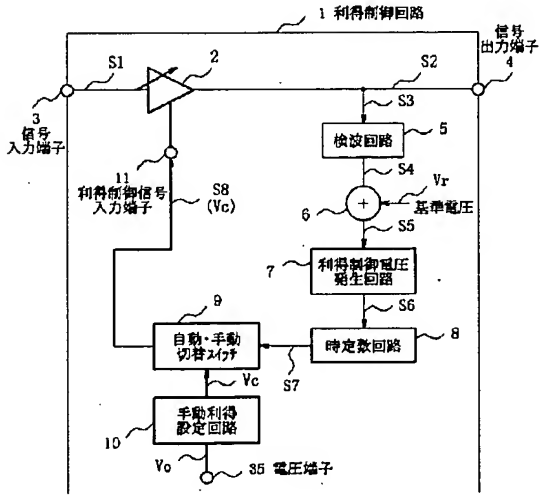
【図６】従来の手動可変電圧発生回路の回路図である。

【符号の説明】

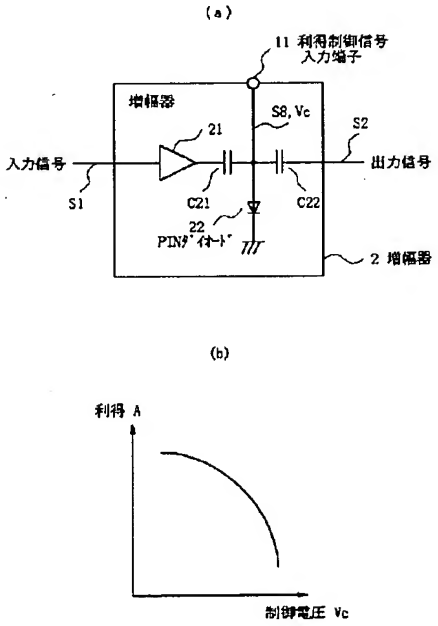
1　利得制御（ＡＧＣ）回路
2，2Ａ　増幅器
3　信号入力端子
4　信号出力端子
5　検波回路
6　比較器
7　利得制御電圧発生回路
8　時定数回路
9　自動・手動切替スイッチ

10　手動利得設定回路
11　利得制御信号入力端子
21　増幅器
22　ＰＩＮダイオード
30　ロータリースイッチ
31　共通端子
32～34　切替端子
35　電圧端子
36～38　抵抗器
40　Ｄ／Ａコンバータ
41　出力端子
43　データ入力回路
Ｃ21，Ｃ22　コンデンサ
Ｒ21　抵抗器

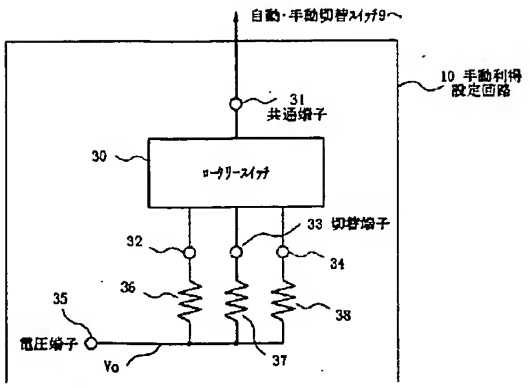
【図１】



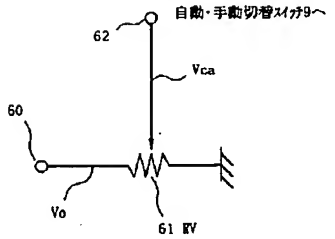
【図２】



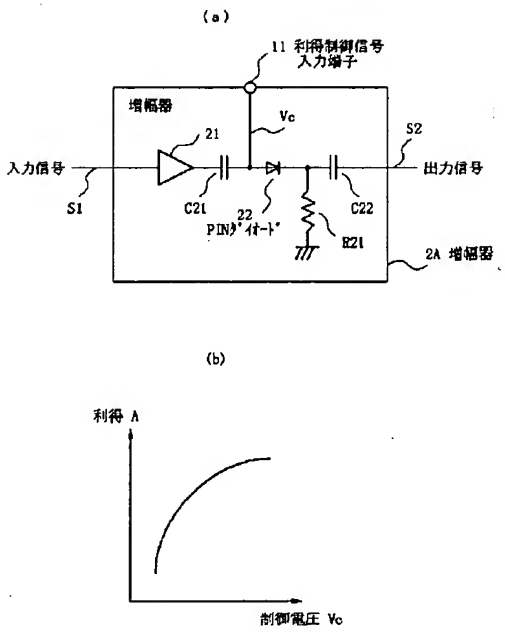
【図４】



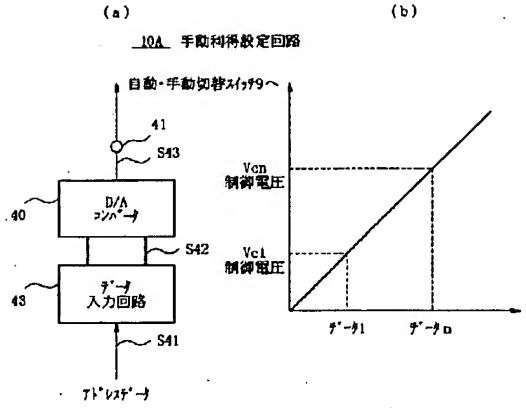
【図６】



【図3】


(a)
11 利得制御信号入力端子
増幅器
Vc
21
S2
入力信号
出力信号
S1
C21
22
PINﾀﾞｲｵｰﾄﾞ
C22
R21
2A 増幅器
(b)
利得 A
制御電圧 Vc

【図5】


(a)
10A 手動利得設定回路
自動・手動切替ｽｲｯﾁ9へ
41
S43
40
D/A ｺﾝﾊﾞｰﾀ
S42
43
ﾃﾞｰﾀ入力回路
S41
ｱﾄﾞﾚｽﾃﾞｰﾀ
(b)
Vcn 制御電圧
Vc1 制御電圧
ﾃﾞｰﾀ1
ﾃﾞｰﾀn

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the manual gain setting method of the gain control circuit which can change an automatic-gain-control method (AGC method) and a manual gain setting method (MGC method) especially, and its approach about the manual gain setting method of the gain control circuit (AGC circuit) of a high-frequency signal, and its approach.
[0002]
[Description of the Prior Art] Patent No. 2778260 is indicated as this conventional kind of a gain control circuit. The indicated gain control circuit is replaced with the automatic-gain-control signal which controls the gain of the above-mentioned gain control circuit automatically at the time of automatic gain control, supplies the electrical potential difference (manual-gain-control signal) which can carry out adjustable manually, and is making gain change and set up at the time of manual gain control. In addition, although the means which produces an adjustable electrical potential difference manually is not indicated by the indicated patent official report, the means shown in the circuit diagram of the manual adjustable electrical-potential-difference generating circuit of drawing 6 can be considered as an example.
[0003] If drawing 6 is referred to, a variable resistor RV 61 will carry out the seal of approval of the constant voltage V0 to an end from a terminal 60, will ground the other end, and will produce the adjustable electrical potential difference Vca from a central terminal for a terminal 62. If the rotator of a variable resistor 61 is turned, the location on the above-mentioned resistor of an end, the other end, and the central terminal of the variable resistor RV 61 which has the resistor of fixed resistance in between changes, and the electrical potential difference Vca of the central terminal to touch-down potential can set up freely. Therefore, at the time of the manual gain setting of the above-mentioned gain control circuit, gain can be continuously changed by using the adjustable electrical potential difference Vca produced from the circuit (variable resistor) shown in drawing 6 as the above-mentioned manual-gain-control signal.
[0004]
[Problem(s) to be Solved by the Invention] In the above-mentioned gain control circuit, since the setting gain of an AGC circuit was not known while a setup of the gain by hand control can be changed continuously (it cannot specify), it needed to act as the monitor of the matter about gains, such as the input-output behavioral characteristics of a high-frequency signal, with the measuring instrument, and the above-mentioned setting gain needed to be measured. That is, at the time of employment, an AGC circuit has the case where he wants to inspect by carrying out a manual setup of the gain, at the time of the maintenance of equipment, and manufacture, although the gain setting by hand control is originally needlessness. To manufacture many AGC circuits of the same class especially, it is required to repeat accuracy and two or more gain settings by easy actuation, and to be able to reappear about gain measurement at each time, because of reduction of a manufacturing cost.
[0005] Therefore, the purpose of this invention is to offer the manual gain setting method of the gain

control circuit which can change the AGC method which cancels the fault of the conventional technique mentioned above and can set up two or more presetting values by easy actuation at the time of the manual gain setting of an AGC circuit, and a MGC method, and its approach.
[0006]
[Means for Solving the Problem] The manual gain-setting method of the gain-control circuit by one of this inventions is a gain-control circuit which has the function which changes the high-frequency amplifier which carries out adjustable gain magnification of the high-frequency signal to an automatic-gain-control condition and a manual gain-setting condition, and is equipped with a gain-setting means set one of two or more of the gain values beforehand defined by supply of the manual-gain-control signal produced by choosing one of two or more of the change terminals as said high-frequency amplifier, in said manual gain-setting condition.
[0007] One of said the manual gain setting methods can take a configuration equipped with the change means to which said gain setting means connected two or more resistors of mutually different resistance between the voltage source which produces a predetermined electrical potential difference, and said two or more change terminals, respectively, and a manual-gain-control signal supply means to supply at the gain control terminal of said high-frequency amplifier by making into said manual-gain-control signal the electrical potential difference produced in the common terminal of said change means.
[0008] The manual gain setting method of this gain control circuit can take the configuration in which said high-frequency amplifier contains the PIN diode which said manual-gain-control signal is supplied and performs adjustable attenuation actuation of said high-frequency signal while being arranged at the path of said high-frequency signal at juxtaposition or a serial.
[0009] One with the another manual gain setting method of said gain control circuit can take a configuration equipped with the data input circuit where said gain setting means produces the digital signal which corresponds by the input of predetermined address data, the D/A converter which changes said digital signal into corresponding analog voltage, and an electrical-potential-difference supply means to supply the gain control terminal of said high-frequency amplifier by making said analog voltage into said manual-gain-control signal.
[0010] The manual gain setting approach of the gain control circuit by one of this inventions It is the manual gain setting approach of a gain control circuit of having the function which changes the high-frequency amplifier which carries out adjustable gain magnification of the high-frequency signal to an automatic-gain-control condition and a manual gain setting condition. In said manual gain setting condition, one of two or more of the gain values beforehand set up by supply of the manual-gain-control signal produced by choosing one of two or more of the change terminals is set as said high-frequency amplifier.
[0011] One of the manual gain setting approaches of said gain control circuit Connect two or more resistors of mutually different resistance between the voltage source and said two or more change terminals of an electronic switch which produce a predetermined electrical potential difference, respectively, and said two or more change terminals are made to produce said manual-gain-control signal, respectively. The approach of supplying one of said the manual-gain-control signals to the gain control terminal of said high-frequency amplifier from the common terminal of said electronic switch by one selection of said change terminal can be taken.
[0012] The manual gain setting approach of this gain control circuit can take the approach of supplying said manual-gain-control signal to the path of said high-frequency signal of said high-frequency amplifier at the PIN diode arranged to juxtaposition or a serial, and carrying out adjustable attenuation of said high-frequency signal.
[0013] One with the another manual gain setting approach of said gain control circuit can produce the digital signal which corresponds by the input of the predetermined address data to a data input circuit, it can change said digital signal into said manual-gain-control signal of the analog voltage which corresponds by the D/A converter, and can take the approach of supplying said manual-gain-control signal to the gain control terminal of said high-frequency amplifier.
[0014]

[Embodiment of the Invention] Next, this invention is explained with reference to a drawing.
[0015] Drawing 1 is the block diagram of the AGC circuit by one of the gestalten of operation of this invention.
[0016] This AGC (automatic gain control) circuit 1 is received in the gain adjustable amplifier 2 which includes the high frequency signal S1 for a transistor etc. from the signal input terminal 3. Amplifier 2 amplifies the high-frequency signal S1, and outputs the high-frequency signal S2 to the signal output terminal 4. Moreover, a part of high-frequency signal which amplifier 2 outputs branches with the high-frequency signal S2, and this branched high-frequency signal S3 is supplied to the detector circuit 5 containing a diode detector etc. A detector circuit 5 detects the high frequency signal S3, and outputs the signal level of the high frequency signal S2 produced in the signal output terminal 4 as detection electrical-potential-difference S4 of a direct current thru/or a low frequency signal.
[0017] Detection electrical-potential-difference S4 is compared with the reference voltage Vr which specifies the signal level of the high frequency signal S2 outputted from this AGC circuit 1 by the comparator 6. When detection electrical-potential-difference S4 and reference voltage Vr are equal, the output (S2) of AGC circuit 1 serves as convention signal level. On the other hand, when there is a difference in detection electrical-potential-difference S4 and reference voltage Vr, the gain control electrical-potential-difference generating circuit 7 whose error voltage S5 is an operational amplifier etc. is supplied from a comparator 6, and the gain control electrical-potential-difference generating circuit 7 amplifies error voltage S5 to suitable level, and supplies the automatic-gain-control signal S6 to the time constant circuit 8. The time constant circuit 8 which is also a low pass filter restricts the signal band of error voltage S5 to a suitable band, and determines mostly the band of the AGC loop formation which consists of an amplifier 2, a detector circuit 5, a comparator 6, a gain control electrical-potential-difference generating circuit 7, and automatic and a manual circuit changing switch 9. The automatic-gain-control signal S7 from the time constant circuit 8 is supplied to automatic and the manual circuit changing switch 9 which changes AGC circuit 1 to an AGC method or a MGC method.
[0018] In operating AGC circuit 1 by the AGC method (automatic-gain-control condition), it supplies the automatic-gain-control signal S8 of the almost same electrical potential difference as the automatic-gain-control signal S7 to the gain control signal input edge (gain control terminal) 11 of amplifier 2 from automatic and the manual circuit changing switch 9. In addition, the single pole double throw switch which connects a common terminal to the gain control signal input edge 11 of an amplifier 2 can be used for automatic and the manual circuit changing switch 9. The variable attenuator which decreases gain is built in amplifier 2, and the gain control signal S8 carries out gain control of amplifier 2 so that the magnitude of attenuation of the above-mentioned variable attenuator may be controlled and the level of the high frequency signal S2 may turn into the above-mentioned convention level.
[0019] When operating AGC circuit 1 by the MGC method (manual-gain-control condition), the above-mentioned AGC loop formation has a loop formation wide opened by automatic and the manual circuit changing switch 9 on the other hand. And automatic and the manual circuit changing switch 9 receive control voltage Vc from the manual gain setting circuit 10, and supplies it to the gain control signal input edge 11 of amplifier 2 by making this control voltage Vc into a manual gain setting signal. Consequently, the gain of amplifier 2 is set as the gain corresponding to control voltage Vc.
[0020] The manual gain setting circuit 10 which receives the predetermined electrical potential difference V0 in the electrical-potential-difference terminal 35, and uses an electrical potential difference V0 as the power source of control voltage Vc can make an output terminal produce one of the control voltage Vc of two or more mutually different electrical potential differences set up beforehand here by choosing one of the change means, for example, the change terminal of a rotary switch, to have two or more change terminals. Therefore, AGC circuit 1 which operates as a MGC method can set up two or more mutually different gains (one) in response to the control voltage (manual gain setting signal) Vc (one) of an electrical potential difference different mutually [the plurality which the manual gain setting circuit 10 generates] which was set up beforehand.
[0021] Moreover, AGC circuit 1 which operates as this MGC method is very simple to carry out gain measurement of two or more gain point of measurement automatically by computer control by

interlocking automatic, the manual circuit changing switch 9, and the manual gain setting circuit 10 with a gain measuring instrument, and laborsaving can raise much more effectiveness by this.
[0022] AGC circuit 1 by the gestalt of operation of drawing 1 is effective in the ability to set up two or more presetting values by easy actuation, respectively at the time of the manual gain setting of the AGC circuit which can change an AGC method and a MGC method as above-mentioned. When inspecting by carrying out a manual setup of the gain at the time of the maintenance of equipment, and manufacture and manufacturing many AGC circuits of the same class especially, about gain measurement at each time, this repeats accuracy and two or more set points by easy actuation, can be reproduced, and has the description that reduction of a big manufacturing cost can be performed.
[0023] Drawing 2 is drawing explaining actuation of the amplifier 2 shown in drawing 1 , and it is drawing in which (a) shows a detail circuit diagram and (b) shows control voltage Vc and relation with the gain A of amplifier 2.
[0024] When drawing 2 is referred to, an amplifier 2 is a variable gain amplifier which cascade connection is carried out to the latter part of the amplifier 21 which amplifies the high frequency signal S1 by a field-effect transistor (FET) etc., and an amplifier 21, and uses as the main components PIN diode 22 which operates as variable attenuator. An anode is connected to the track of a high-frequency signal, and, as for PIN diode 22, the cathode is grounded. The above-mentioned anode and the gain control signal input terminal 11 are connected, the automatic-gain-control signal S8 is supplied to an automatic-gain-control condition (AGC method), and control voltage (manual-gain-control signal) Vc is supplied to a manual-gain-control condition (MGC method), respectively. In addition, between the above-mentioned anode and the gain control signal input terminal 11, the leak prevention circuit (not shown) of high-frequency signals, such as a choke coil and a resistor, is prepared. Moreover, although a direct current flows to PIN diode 22, the capacitor C22 is inserted for the capacitor C21 between PIN diode 22 and the outgoing end of amplifier 21 between amplifier 21 and PIN diode 22 for DC blocking, respectively so that this direct current may flow to amplifier 21 or an external circuit and may not do a bad influence mutually.
[0025] now, the control voltage Vc of a forward electrical potential difference carries out a seal of approval to the gain control signal input terminal 11 -- having (when it being a MGC method) -- the value more than 50ohm (it changes with frequencies of a high-frequency signal) to the control voltage Vc becomes [the resistance over the high-frequency signal of PIN diode 22] large -- it is alike, and it follows and decreases to about several ohms. Therefore, since the magnitude of attenuation of the high-frequency signal by PIN diode 22 increases with the increment in control voltage Vc, the gain A of the amplifier 2 whole falls and amplifier 2 operates as a variable gain amplifier (refer to (b)). From drawing 2 (b), amplifier 2 understands the value of the control voltage Vc for acquiring the desired gain A.
[0026] Drawing 3 is drawing explaining actuation of amplifier 2A which can be replaced with and used for the amplifier 2 shown in the gestalt of operation of drawing 1 , and it is drawing in which (a) shows a detail circuit diagram and (b) shows control voltage Vc and relation with the gain A of amplifier 2A.
[0027] When drawing 3 is referred to, it is the variable gain amplifier with which amplifier 2A also uses as the main components amplifier 21 and PIN diode 22 by which cascade connection was carried out to the latter part of amplifier 21. However, as for PIN diode 22, the anode is connected to the serial on the track of a high-frequency signal. The above-mentioned anode and the gain control signal input terminal 11 are connected, the gain control signal S8 is supplied to an automatic-gain-control condition, and control voltage Vc is supplied to a manual-gain-control condition, respectively. In addition, between the above-mentioned anode and the gain control signal input terminal 11, the leak prevention circuit (not shown) of high-frequency signals, such as a choke coil and a resistor, is prepared. Moreover, the cathode of PIN diode 22 is grounded by the resistor R21, in order to make the return circuit of control voltage Vc. Furthermore, the capacitor C22 is inserted for the capacitor C21 between PIN diode 22 and the outgoing end of an amplifier 21 between an amplifier 21 and PIN diode 22 like the case of drawing 2 for DC blocking, respectively.
[0028] now, the control voltage Vc of a forward electrical potential difference carries out a seal of approval to the gain control signal input terminal 11 -- having (when it being a MGC method) -- control

voltage Vc becomes [the resistance over the high-frequency signal of PIN diode 22] large -- it is alike, and follows and decreases. Therefore, the magnitude of attenuation of the high-frequency signal by PIN diode 22 decreases with the increment in control voltage Vc, the gain A of the whole amplifier 2A increases, and amplifier 2A also operates as a variable gain amplifier (refer to (b)). The value of the control voltage Vc for acquiring the desired gain A to amplifier 2A can be determined from drawing 2 (b). In addition, Amplifier 2 and 2A has the reverse gain change to control voltage Vc, and it becomes settled by the method of a setup of the level change direction of the gain control electrical potential difference S5 from the gain control electrical-potential-difference generating circuit 6 to level change of the high frequency signal S2, or control voltage Vc which is adopted as AGC circuit 1.

[0029] In addition, of course in the amplifier 2 and 2A shown in drawing 2 and drawing 3 , PIN diode 22 may be arranged in the preceding paragraph of amplifier 21 according to a situation.

[0030] Drawing 4 is the block diagram of an example of the manual gain setting circuit 10 used for AGC circuit 1 of drawing 1 .

[0031] This manual gain setting circuit 10 is equipped with two or more resistors 36, 37, and 38 by which resistance differs from the rotary switch 30 used as a connection electronic switch which has two or more change terminals mutually. The common terminal 31 of a rotary switch 30 is connected to one of the change terminals of automatic and the manual circuit changing switch 9. Moreover, resistors 36, 37, and 38 are connected to the change terminals 32, 33, and 34 of a rotary switch 30, respectively. And common connection of another terminal of resistors 36, 37, and 38 is made at the electrical-potential-difference terminal 35 to which the predetermined electrical potential difference V0 is supplied. An electrical potential difference V0 and the resistance of resistors 36, 37, and 38 will be decided to be the value from which the control voltage Vc which makes amplifier 2 or 2A produce the desired gain A, respectively is obtained, i.e., the value which can carry out the seal of approval of the desired control voltage Vc to PIN diode 22, in drawing 2 and drawing 3 . In addition, the number of the resistors corresponding to the number of change terminals and this change terminal of a rotary switch 30 of your determining according to the number of amplifier 2 or the gain setting values of a request of 2A is natural.

[0032] If the shaft of the common terminal 31 of a rotary switch 30 is turned now, the change terminal connected to a common terminal 31 will change. Consequently, the resistor connected to a common terminal 31 changes. Change selection is made by the connection change of this rotary switch 30 at one of the resistors 36, 37, and 38, and the above-mentioned resistor becomes things by it. Since PIN diode 22 of the resistor of this Fig., drawing 2 , or drawing 3 is connected to the electrical-potential-difference terminal 35 between touch-down potentials by the MGC method at a serial, change selection of the above-mentioned resistor by the rotary switch 30 makes the control voltage Vc by which a seal of approval is carried out to PIN diode 22 change. Therefore, the directions graduation of the change terminal of a rotary switch 30, amplifier 2, or the gain A of 2A can be made to correspond to one to one by making it the electrical potential difference which acquires the gain A of a request of the value of the control voltage Vc which can change.

[0033] The combinational circuit with the resistor which was connected to the electronic switch and two or more above-mentioned change terminals which have two or more change terminals shown in drawing 4 as above-mentioned, respectively and by which resistance differs mutually is setting up the control voltage Vc of a MGC method according to the change terminal to which the common terminal of the above-mentioned electronic switch is connected, respectively, and has the description that the correctness and multiple set point is repeated by easy actuation, and it can reappear. This is effective especially because of laborsaving, when it manufactures many AGC circuits 1 of the same class, and a MGC method performs gain measurement of each time of Amplifier 2 or 2A.

[0034] Drawing 5 is the block diagram of another manual gain setting circuit 10A which can be used for AGC circuit 1 of drawing 1 .

[0035] In this manual gain setting circuit 10A, the data input circuit 43 which memorizes two or more data 1 - n (n is a positive integer) outputs the digital signal S42 which corresponds by the input of the predetermined address data S41. The value of this digital signal S42 supports the control voltage Vc

which should be supplied to amplifier 2 or the gain control signal input edge 11 of 2A, respectively. For example, when address data S41 are Data n, control voltage Vcn is supported (refer to (b)). A digital signal S42 is supplied to D/A converter 40, and D/A converter 40 changes it into the analog voltage S43 which corresponds a digital signal S42. This analog voltage S3 is supplied to amplifier 2 or the gain control signal input edge 11 of 2A through automatic and a manual circuit changing switch from the output terminal 41 of manual gain setting circuit 10A, and controls the magnitude of attenuation of amplifier 2 or variable attenuator with built-in 2A as control voltage Vc. This manual gain setting circuit 10A is suitable for especially use with the MGC method of AGC circuit 1 by which computer control is carried out.

[0036]

[Effect of the Invention] As explained above, this invention is a gain control circuit which has the function which changes the high-frequency amplifier which carries out adjustable gain magnification of the high-frequency signal to an automatic-gain-control condition and a manual gain setting condition. Since it has a gain setting means to set one of two or more of the gain values beforehand defined by supply of the manual-gain-control signal produced by choosing one of two or more of the change terminals in said manual gain setting condition as said high-frequency amplifier It is effective in the ability to set up two or more presetting values by easy actuation at the time of the manual gain setting of the above-mentioned AGC circuit. When inspecting by carrying out a manual setup of the gain at the time of the maintenance of equipment, and manufacture and manufacturing many AGC circuits of the same class especially, about gain measurement at each time, this repeats accuracy and two or more set points by easy actuation, can be reproduced, and produces the effectiveness that reduction of a big manufacturing cost can be performed.

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MANUAL GAIN SETTING SYSTEM AND ITS METHOD FOR GAIN CONTROL CIRCUIT
[Ritoku seigyo kairo no shudou ritoku settei houshiki oyobi sono houhou]

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[Claims] /2*

[Claim 1] With respect to a gain control circuit that has the function of switching between an automatic gain control condition and a manual gain setting condition for a high-frequency amplifier, which performs variable gain amplification on high-frequency signals,

a manual gain setting system for a gain control circuit characterize by being equipped with a gain setting means which, in a manual gain setting condition, sets in the high-frequency amplifier one of preset gain values based on the supplied manual gain control signal that is generated by one of the multiple switch terminals being selected.

[Claim 2] A manual gain setting system for a gain control circuit according to Claim 1, characterized by the gain setting means being equipped with: a switching means, in which multiple resistors having mutually different resistance values are connected between a voltage source that generates a predetermined voltage and multiple switch terminals mentioned earlier; and a manual gain control signal feeding means, which supplies the voltage generated in the common terminal of the above switching means to the gain control terminal of the high-frequency amplifier as a manual gain control signal.

[Claim 3] A manual gain setting system for a gain control circuit according to Claim 2, characterized by the high-frequency amplifier being positioned in parallel to, or series with, the passage for the high-frequency signals and being provided with a PIN diode that performs variable attenuation on the high-frequency signals after receiving the manual gain control signals.

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[Claim 4] A manual gain setting system for a gain control circuit according to Claim 1, characterized by the gain setting means being equipped with: a data inputting circuit that generates a corresponding digital signal after receiving predetermined address data; a D/A converter that converts the digital signal into a corresponding analog voltage; and a voltage feeding means that supplies the analog voltage to the gain control terminal of the high-frequency amplifier as the manual gain control signal.

[Claim 5] With respect to a manual gain setting method for a gain control circuit that has a function to switch a high-frequency amplifier, which performs variable gain amplification on high-frequency signals, between an automatic gain control condition and a manual gain setting condition,

a manual gain setting method for a gain control circuit characterized by, during the manual gain setting condition, one of the preset gain values being set in the high-frequency amplifier based on the supplied manual gain control signal that was generated by one of the multiple switch terminals being selected.

[Claim 6] A manual gain setting method for a gain control circuit according to Claim 5, characterized by: multiple resistors having mutually different resistances being connected to points between the voltage source, which generates a predetermined voltage, and the multiple switch terminals of the switching circuit in order to cause the multiple switch terminals to generate the manual gain control signals; and selecting one of the switch terminals in order to supply one of the manual gain control signals

from the common terminal of the switching circuit to the gain control terminal of the high-frequency amplifier.

[Claim 7] A manual gain setting method for a gain control circuit according to Claim 6, characterized by the manual gain control signal being supplied to the PIN diode positioned in parallel to, or series with, the high-frequency signal passage of the high-frequency amplifier in order to perform variable attenuation on the high-frequency signals.

[Claim 8] A manual gain setting method for a gain control circuit according to Claim 5, characterized by: a corresponding digital signal being generated in response to predetermined address data being input to the data inputting circuit; the digital signal being converted to the manual gain control signal of a corresponding analog voltage by means of a D/A converter; and the manual gain control signal being supplied to the gain control terminal of the high-frequency amplifier.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] The present invention relates to a manual gain setting system and its method for a gain control circuit (AGC circuit) for high-frequency signals, specifically to a manual gain setting system and its method for a gain control circuit by which a switch can be made between an automatic gain control system (AGC system) and a manual gain setting system (MGC system).

[0002]

[Related Art] For this type of conventional gain control circuit, Pat. No.2778260 has been disclosed. During automatic gain adjusting, this

disclosed gain control circuit changes/sets the gain by supplying a voltage (manual gain control signal) that can be changed manually, instead of an automatic gain control signal which is utilized to automatically control the gain of the gain control circuit during automatic gain control. In addition, although the disclosed patent publication does not mention a means for manually generating a variable voltage, one conceivable example is the means indicated in the circuit diagram of the manual variable voltage generating circuit of Figure 6.

[0003] According to Figure 6, a variable resistor RV61 applies a constant voltage, V0, on one end from a terminal 60, and its other end is grounded. A variable voltage, Vca, is generated from the central terminal to a terminal 62. When the rotor of the variable resistor 61 is rotated, the position on a resistor of the central terminal of the variable resistor RV61, which has the resistor having a constant resistance value at a point between one end and the other end, changes, and the voltage, Vca, of the central terminal with respect to the ground potential can be set freely. Therefore, by using the variable voltage, Vca, generated from the (variable resistor) circuit shown in Figure 6 as the manual gain control signal mentioned in the above, the gain can be continually changed during the manual gain setting of the gain control circuit.

[0004]

[Problems that the Invention is to Solve] In the gain control circuit described in the above, manual gain setting can be continually changed, but the set gain in the AGC circuit cannot be known (cannot be specified). Therefore, it is possible to measure the set gain by monitoring

gain-related items, such as the input/output characteristic of the high-frequency signals, by means of measuring equipment. In other words, the AGC circuit originally does not require manual gain setting during operation, but it is sometimes desired that a testing be done by manually setting the gain during the maintenance or manufacture of the device. In particular, when manufacturing many AGC circuits of the same type, it is necessary for the achievement of a cost reduction to be able to repeatedly reproduce accurate and multiple gain settings for every gain measurement through a simple procedure.

[0005] In light of this, the aim of the invention is to solve the above shortcomings of the conventional technique and to provide a /3 manual gain setting system and its method for a gain control circuit by which multiple preset values can be set through a simple procedure during the manual gain setting of the AGC circuit and by which a switch can be made between an AGC system and MGC system.

[0006]

[Means for Solving the Problems] The manual gain setting system for a gain control circuit which is one example of the invention is a gain control circuit that has the function of switching between an automatic gain control condition and a manual gain setting condition for the high-frequency amplifier, which performs variable gain amplification on high-frequency signals. It is equipped with a gain setting means which, in the manual gain setting condition, sets in the high-frequency amplifier one of the preset gain values based on the supplied manual gain control signal that is generated by one of the multiple switch terminals being

selected.

[0007] One example of the manual gain setting system can have a structure in which the gain setting means is equipped with: a switching means, in which multiple resistors having mutually different resistance values are connected between a voltage source that generates a predetermined voltage and multiple switch terminals mentioned earlier; and a manual gain control signal feeding means, which supplies the voltage generated in the common terminal of the above switching means to the gain control terminal of the high-frequency amplifier as the manual gain control signal.

[0008] The manual gain setting system of the above gain control circuit can have a structure in which the high-frequency amplifier is positioned in parallel to, or series with, the passage for the high-frequency signals and is provided with a PIN diode that performs variable attenuation on the high-frequency signals after receiving the manual gain control signals.

[0009] Another example of the manual gain setting system of the gain control circuit can have a structure in which the gain setting means is equipped with: a data inputting circuit that generates a corresponding digital signal after receiving predetermined address data; a D/A converter that converts the digital signal into a corresponding analog voltage; and a voltage feeding means that supplies the analog voltage to the gain control terminal of the high-frequency amplifier as the manual gain control signal.

[0010] According to one example of the invention, the manual gain

setting method of the gain control circuit is a manual gain setting method for a gain control circuit that has a function to switch the high-frequency amplifier, which performs variable gain amplification on high-frequency signals, between an automatic gain control condition and a manual gain setting condition. In the manual gain setting condition, one of the preset gain values is set in the high-frequency amplifier based on the supplied manual gain control signal that was generated by one of the multiple switch terminals being selected.

[0011] According to one example of the manual gain setting method of the gain control circuit, multiple resistors having mutually different resistances are connected to points between the voltage source, which generates a predetermined voltage, and the multiple switch terminals of the switching circuit in order to cause the multiple switch terminals to generate the manual gain control signals. By then selecting one of the switch terminals, one of the manual gain control signals can be fed from the common terminal of the switching circuit to the gain control terminal of the high-frequency amplifier.

[0012] According to the manual gain setting method of the gain control circuit, it is possible to supply the manual gain control signal to the PIN diode positioned in parallel to, or series with, the high-frequency signal passage of the high-frequency amplifier in order to perform variable attenuation on the high-frequency signals.

[0013] According to another example of the manual gain setting method of the gain control circuit, a corresponding digital signal is generated in response to predetermined address data being input to the data inputting

circuit, the digital signal is converted to the manual gain control signal of a corresponding analog voltage by means of a D/A converter, and the manual gain control signal is supplied to the gain control terminal of the high-frequency amplifier.

[0014]

[Embodiments of the Invention] Next, the invention will be explained by referring to accompanying drawings.

[0015] Figure 1 is a block diagram of the AGC circuit of one embodiment of the invention.

[0016] This AGC (automatic gain control) circuit 1 receives a high-frequency signal S1 from a signal input terminal 3 via a gain-variable amplifier 2, which comprises a transistor and the like. The amplifier 2 amplifies the high-frequency signal S1 and outputs a high-frequency signal S2 to a signal output terminal 4. Moreover, part of the high-frequency signal output by the amplifier 2 is branched away from the high-frequency signal S2, and this branched high-frequency signal S3 is supplied to a detecting circuit 5, which comprises a diode detector and the like. The detecting circuit 5 detects the high-frequency signal S3, and the signal level of the high-frequency signal S2 generated in the signal output terminal 4 is output as a detected voltage S4 of a DC or low-frequency signal.

[0017] The detected voltage S4 is compared with a reference voltage Vr, which stipulates the signal level of the high-frequency signal S2 output from the AGC circuit 1, by a comparator 6. When the detected voltage S4 and the reference voltage Vr are the same, the output (S2) of the AGC

circuit 1 will be at the stipulated signal level. On the other hand, if there is a difference between the detected voltage S4 and reference voltage Vr, an error voltage S5 is supplied from the comparator 6 to the gain control voltage generating circuit 7, which is an operating amplifier, etc., and the gain control voltage generating circuit 7 amplifies the error voltage S5 to an appropriate level and supplies the resultant automatic gain control signal S6 to a time constant circuit 8. The time constant circuit 8, which is also a low-pass filter, limits the signal band of the error voltage S5 to an appropriate band, and roughly determines the band of the AGC loop consisting of the amplifier 2, detecting circuit 5, comparator 6, gain control voltage generating circuit 7, and automatic/manual switch 9. The automatic gain control signal S7 from the time constant circuit 8 is supplied to the automatic/manual switch 9, which switches the AGC circuit 1 between the AGC system and MGC system.

[0018] When operating the AGC circuit 1 by the AGC system (automatic gain control condition), an automatic gain control signal S8 having roughly the same voltage as that of an automatic gain control signal S7 is supplied from the automatic/manual switch 9 to the gain control signal input terminal (gain control terminal) 11 of the amplifier 2. In addition, for the automatic/manual switch 9, a single pole double throw switch that connects the common terminal to the gain control signal input terminal 11 of the amplifier 2 can be used. The amplifier 2 has a built-in /4 variable attenuator, which reduces the gain, and the gain control signal S8 controls the gain of the amplifier 2 in a manner such that the level of the high-frequency signal S2 will coincide with the above-mentioned

stipulated level by controlling the attenuation of the variable attenuator.

[0019] On the other hand, when operating the AGC circuit 1 by the MGC system (manual gain control condition), the AGC loop becomes opened by the automatic/manual switch 9. Then, the automatic/manual switch 9 receives a control voltage Vc from the manual gain setting circuit 10 and supplies this control voltage Vc as a manual gain setting signal to the gain control signal input terminal 11 of the amplifier 2. As a result, the gain of the amplifier 2 is set to a gain that corresponds to the control voltage Vc.

[0020] Incidentally, the manual gain setting circuit 10, which receives prescribed voltage, V0, in a voltage terminal 35 and which then uses the voltage, V0, as the power source for the control voltage, Vc, can generate one of the mutually different preset control voltages, Vc, by selecting one of the switch terminals of a switching means, such as a rotary switch, which is equipped with multiple switch terminals. Therefore, the AGC circuit 1 operating on the MGC system can set one of the multiple, mutually different gains by receiving one of the mutually different preset control voltages (manual gain setting signals), Vc, generated by the manual gain setting circuit 10.

[0021] Also, the AGC circuit operating on the MGC system 1 easily allows for automatic gain measurement of multiple gain measuring points by means of computer control by interlocking the automatic/manual switch 9 and manual gain setting circuit 10 with gain measuring equipment. This can further increase the laborsaving effect.

[0022] As described in the above, the AGC circuit 1 of the embodiment of Figure 1 has the effect of setting multiple preset values by a simple procedure during the manual gain setting of the AGC circuit in which a switch can be made between the AGC system and MGC system. This has a characteristic in that, when performing a test by manually setting the gain during the maintenance or manufacture of the device, particularly when manufacturing many AGC circuits of the same type, accurate and multiple setting values can be reproduced repeatedly through a simple procedure for each gain measurement and in that the manufacture cost can therefore be greatly reduced.

[0023] Figure 2 is for explaining the operation of the amplifier 2 indicated in Figure 1. (a) shows a detailed circuit diagram, and (b) shows the relationship between the control voltage, Vc, and the gain, A, of the amplifier 2.

[0024] According to Figure 2, the amplifier 2 is a variable-gain amplifier composed mainly of an amplifier 21, which amplifies a high-frequency signal S1 by means of a field effect transistor (FET) or the like, and a PIN diode 22, which is cascaded to the latter part of the amplifier 21 and operates as a variable attenuator. The anode of the PIN diode 22 is connected to a high-frequency signal line, while its cathode is grounded. The above anode and the gain control signal input terminal 11 are connected to each other, and an automatic gain control signal S8 and a control voltage (manual gain control signal), Vc, are supplied during the automatic gain control condition (AGC system) and manual gain control condition (MGC system), respectively. Moreover, a leakage preventing

circuit (not shown) for high-frequency signals such as a choke coil or a resistor is provided to a point between the anode and the gain control signal input terminal 11. Moreover, in order to prevent a DC current, which runs in the PIN diode 22, from running in the amplifier 21 or an external circuit and causing mutual damage, a capacitor C21 is inserted between the amplifier 21 and PIN diode 22, and a capacitor C22 is inserted between the PIN diode 22 and the output terminal of the amplifier 21, in order to block the DC current.

[0025] When a positive control voltage, Vc, is applied to the gain control signal input terminal 11 (in the case of the MGC system), the resistance value corresponding to the high-frequency signal of the PIN diode 22 decreases from a value higher than 50Ω (It varies depending on the frequency of the high-frequency signal) to about several Ω as the control voltage, Vc, increases. Since the attenuation of the high-frequency signal caused by the PIN diode 22 increases along with the increase in the control voltage, Vc, the overall gain, A, of the amplifier 2 decreases, and the amplifier 2 operates as a variable-gain amplifier (See (b)). Figure 2(b) reveals the value of the control voltage, Vc, required to achieve a desired gain, A, in the amplifier 2.

[0026] Figure 3 is for explaining the operation of an amplifier 2A that can be utilized in lieu of the amplifier 2 shown in the embodiment of Figure 1. (a) is a detailed circuit diagram, and (b) is a graph indicating the relationship between the control voltage, Vc, and the gain, A, of the amplifier 2A.

[0027] According to Figure 3, the amplifier 2A is also a variable-gain

amplifier composed mainly of an amplifier 21 and a PIN diode 22 cascaded to the latter part of the amplifier 21. Note, however, that the anode of the PIN diode 22 is connected in series to the high-frequency signal line. The above anode and the gain control signal input terminal 11 are connected to each other, and a gain control signal S8 and a control voltage, Vc, are supplied during the automatic gain control condition and manual gain control condition, respectively. Moreover, a leakage preventing circuit (not shown) for high-frequency signals such as a choke coil or a resistor is provided to a point between the anode and the gain control signal input terminal 11. The cathode of the PIN diode 22 is grounded via a resistor R21 in order to create a return circuit for the control voltage, Vc. Moreover, in the same manner as in the case of Figure 2, a capacitor C21 is inserted between the amplifier 21 and PIN diode 22, and a capacitor C22 is inserted between the PIN diode 22 and the output terminal of the amplifier 21, in order to block the DC current.

[0028] When a positive control voltage, Vc, is applied to the gain control signal input terminal 11 (in the case of the MGC system), the resistance value corresponding to the high-frequency signal of the PIN diode 22 decreases as the control voltage, Vc, increases. Since the attenuation of the high-frequency signal caused by the PIN diode 22 decreases along with an increase in the control voltage, Vc, the overall gain, A, of the amplifier 2A increases, and the amplifier 2A also operates as a variable-gain amplifier (See (b)). The value of the control voltage, Vc, required to achieve a desired gain, A, in the amplifier 2A can be /5 determined based on Figure 2(b). Moreover, the gain changes of the

amplifiers, 2 and 2A, with respect to the control voltage, Vc, are mutually opposite. Which of them will be used for the AGC circuit 1 is determined by the method for setting the direction of the level change in the gain control voltage S5 from the gain control voltage generating circuit 6, or for setting the control voltage, Vc, in response to the level change in the high-frequency signal S2.

[0029] Needless to say, the PIN diode 22 can be located in the front part of the amplifier 21 of the amplifiers, 2 and 2A, indicated in Figure 2 and Figure 3, respectively, depending on the situation.

[0030] Figure 4 is a structural drawing of one example of the manual gain setting circuit 10 used for the AGC circuit 1 of Figure 1.

[0031] This manual gain setting circuit 10 is equipped with a rotary switch 30, which is utilized as a connection switching circuit having multiple switch terminals, and multiple resistors, 36, 37, and 38, having mutual different resistance values. The common terminal 31 of the rotary switch 30 is connected to one of the switch terminals of the automatic/manual switch 9. The switch terminals, 32, 33, and 34, of the rotary switch 30 are connected to the resistors, 36, 37, and 38, respectively. The other terminals of the resistors, 36, 37, and 38, in Figures 2 and 3 are commonly connected to a voltage terminal 35 to which a predetermined voltage, V0, is supplied. The voltage, V0, and the resistance values of the resistors, 36, 37, and 38, are determined as values that can yield a control voltage, Vc, that will cause a desired gain, A, in the amplifier, 2 or 2A, in other words, as values that allow a desired control voltage, Vc, to be applied to the PIN diode 22. Needless

to say, the number of the switch terminals of the rotary switch 30 and the number of the resistors corresponding to the switch terminals can be determined in accordance with the number of desired gain setting values of the amplifier, 2 or 2A.

[0032] When the shaft of the common terminal 31 of the rotary switch 30 is turned, the switch terminal connected to the common terminal 31 is changed. As a result, the resistor connected to the common terminal 31 is changed. Because of this connecting switching of the rotary switch 30, the resistor is selectively switch to one of the resistors, 36, 37, and 38. In the MGC system, the resistors shown in the figure and the PIN diode 22 of Figure 2 or Figure 3 are connected in series to the voltage terminal 35 in a manner such that it sandwiches them with the ground potential. Therefore, the selective switching of the resistors by means of the rotary switch 30 will change the control voltage, Vc, applied to the PIN diode 22. Therefore, by setting the variable value of the control voltage, Vc, to a voltage with which a desired gain, A, can be obtained, the indicator scales of the switch terminals of the rotary switch 30 and the gain, A, of the amplifier, 2 or 2A, can be made to correlate with each other one-on-one.

[0033] As described earlier, the combination circuit in Figure 4, which comprises the switching circuit that has multiple switch terminals as well as the resistors that have mutually different resistance values and that are connected to the corresponding multiple switch terminals, has a characteristic in that accurate and multiple setting values can be reproduced repeatedly through a simple procedure by individually

setting an MGC-system control voltage, Vc, in accordance with the switch terminal connected to the common terminal of the switching circuit. This is particularly effective in terms of laborsaving when each gain measurement of the amplifier, 2 or 2A, is carried out by the MGC system, for example, when manufacturing many AGC circuits 1 of the same type.

[0034] Figure 5 is a structural drawing of another manual gain setting circuit 10A that can be used for the AGC circuit 1 of Figure 1.

[0035] In this manual gain setting circuit 10A, a data inputting circuit 43, which stores multiple pieces of data, 1 - n (n = positive integer), outputs a corresponding digital signal S42 in response to predetermined address data S41 it received. The value of this digital signal S42 corresponds to the control voltage, Vc, that should be supplied to the gain control signal input terminal 11 of the amplifier, 2 or 2A. For example, if the address data S41 is data n, it corresponds to the control voltage, Vcn (See (b)). The digital signal S42 is supplied to the D/A converter 40, and the D/A converter 40 converts the digital signal S42 into a corresponding analog voltage S43. This analog voltage S3 is supplied to the gain control signal input terminal 11 of the amplifier, 2 or 2A, from the output terminal 41 of the manual gain setting circuit 10A via the automatic/manual switch, and then controls the attenuation of the built-in variable attenuator of the amplifier, 2 or 2A, as a control voltage, Vc. This manual gain setting circuit 10A can be utilized particularly suitably with the MGC system in the computer-controlled AGC circuit 1.

[0036]

[Effects of the Invention] As explained earlier, the present invention is a gain control circuit having a function to switch the high-frequency amplifier, which performs variable gain amplification on high-frequency signals, between the automatic gain control condition and the manual gain setting condition. Since it is equipped with a gain setting means which, in the manual gain setting condition, sets one of the preset multiple gain values, in the high-frequency amplifier in response to the supplied manual gain control signal generated by one of the multiple switch terminals being selected. This has an effect in that multiple preset values can be set through a simple procedure during the manual gain setting of the AGC circuit. This demonstrates the effect of greatly reducing the manufacture cost since accurate and multiple set values can be repeatedly reproduced through a simple procedure during each gain measurement when carrying out a test by manually setting the gain during the maintenance or manufacture of the device, particularly when manufacturing many AGC circuits of the same type.

[Brief Description of the Drawings]

[Figure 1] A block diagram of the AGC circuit of one embodiment of the invention.

[Figure 2] Figures for explaining the operation of the amplifier 2 shown in Figure 1. (a) is a detailed circuit diagram, and (b) is a graph indicating the relationship between the control voltage, Vc, and the gain, A, of the amplifier 2.

[Figure 3] Figures for explaining the operation of the amplifier 2A that can be used instead of the amplifier 2 shown in the embodiment

of Figure 1. (a) is a detailed circuit diagram, and (b) is a graph showing the relationship between the control voltage, Vc, and the gain, A, of the amplifier 2A.

[Figure 4] A structural drawing of one example of the manual gain setting circuit 10 used in the AGC circuit 1 of Figure 1. /6

[Figure 5] A structural drawing of another example of another manual gain setting circuit 10A that can be used for the AGC circuit 1 of Figure 1.

[Figure 6] A circuit diagram of a conventional manual variable voltage generating circuit.

[Description of the Reference Numerals]

1 = gain control (AGC) circuit

2, 2A = amplifier

3 = signal input terminal

4 = signal output terminal

5 = detecting circuit

6 = comparator

7 = gain control voltage generating circuit

8 = time constant circuit

9 = automatic/manual switch

10 = manual gain setting circuit

11 = gain control signal input terminal

21 = amplifier

22 = PIN diode

30 = rotary switch

31 = common terminal

32 - 34 = switch terminal

35 = voltage terminal

36 - 38 = resistor

40 = D/A converter

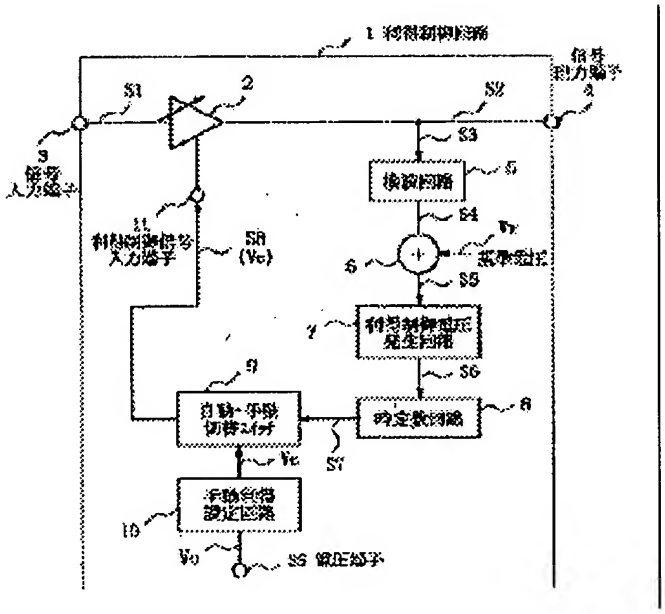
41 = output terminal

43 = data inputting circuit

C21, C22 = capacitor

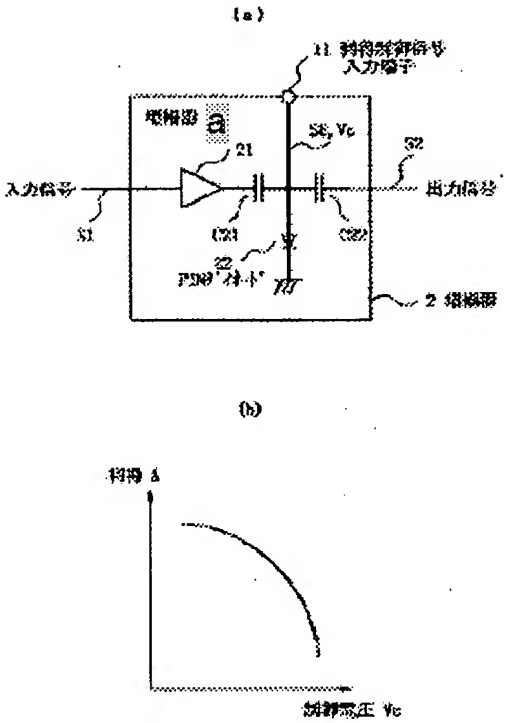
R21 = resistor

[Figure 1]



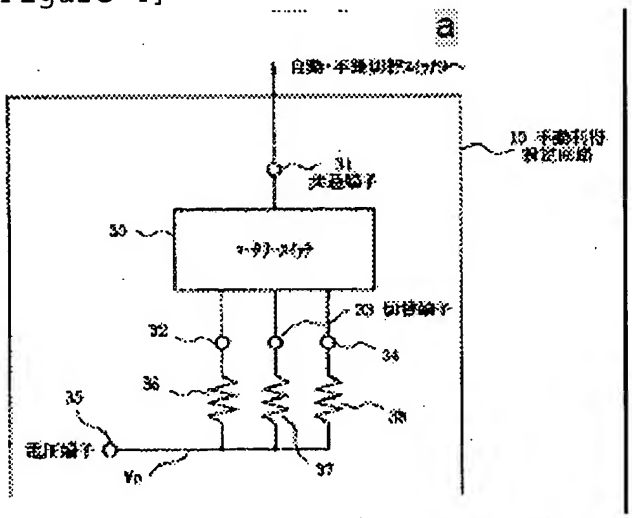
Key: Vr) reference voltage.

[Figure 2]



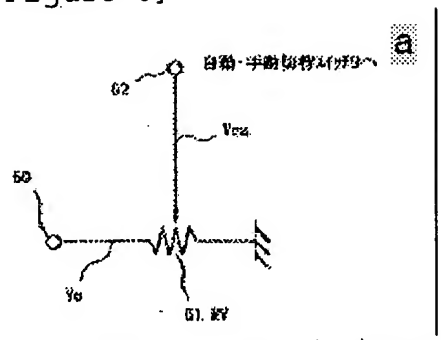
Key: S1)input signal; S2)output signal; a)amplifier; A)Gain; Vc)Control Voltage.

[Figure 4]



Key: a)To automatic/manual switch 9.

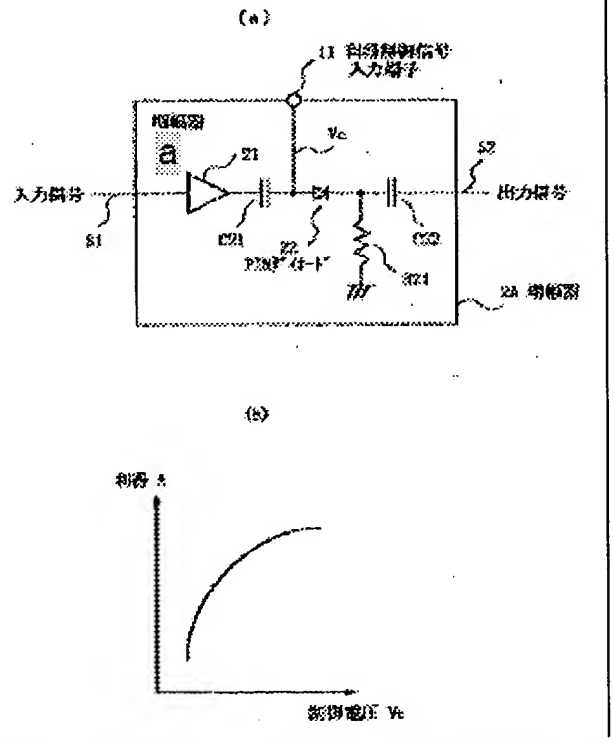
[Figure 6]



Key: a)To automatic/manual switch 9.

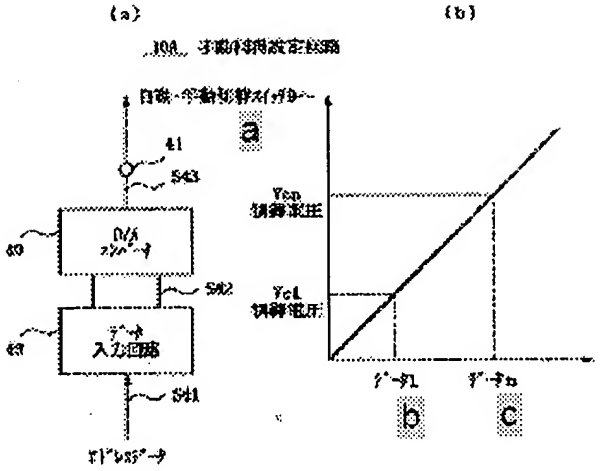
[Figure 3]

/7



Key: S1)input signal; S2)output signal; a)amplifier; A)Gain; Vc)Control Voltage.

[Figure 5]



Key: 10A) manual gain setting circuit; 40) D/A converter; 43) data inputting circuit; S41) address data; Ycn) control voltage; Yc1) control voltage; a) To automatic/manual switch 9; b) Data 1; c) Data n.